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Growing Industrial Hemp

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Quick Grow Facts

Varieties: Health Canada Approved List

Soil: Well-drained, loamy, Not compacted. pH above 6.0

Seedbed: Fine, firm, level 8-10°C, at 2-4 cm

Seed Depth: 2-3 cm

Seeding Rate:
Fibre: 200-250 plants per msq.
Seed: 100-150 plants per msq.

Final Plant Population:
Fibre: 200-250 plants per msq.
Seed: 100-150 plants per msq.

Fertility:
Nitrogen: 90-125 kg/ha
Phosphate: 23-75 kg/ha
Potash: 0-70 kg/ha

Weed Control:
For fibre: None needed
For seed: None needed
No herbicides registered

Diseases and Pests:
No pesticides registered

Harvest:
Fibre: During pollination
Seed: When 60% of seed is ripe, 22-30% moisture

Retting: 14-21 days
Turn once or twice

Storage:
Stalk moisture is <15%
Seed moisture is 12%

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Introduction

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Hemp (Cannabis sativa) is one of the oldest cultivated plants in the world. For centuries, the hemp plant was grown to produce fibres for ropes, sails and clothing. It was grown in Canada and the United States until the early 1930's, when both governments banned it because it contains the substance delta-9 tetra-hydrocannabinol (THC), the hallucinogen found in marijuana and its derivatives.

In 1994, tobacco farmer Joe Strobel and his engineer partner, Geof Kime, obtained a research permit to determine the feasibility of growing hemp as a replacement for the declining tobacco acreage in south-western Ontario. They formed Hempline, Inc. and continue to develop a hemp processing business in Delaware, Ontario. In 1995 and 1996, Gordon Scheifele of Ridgetown College, University of Guelph (R.C.U.G.) was granted similar permits in cooperation with Claude Pinsonneault of Chatham. The following year, Pinsonneault and Jean Laprise of Pain Court formed Kenex, Ltd. They have been active in development of the industry to the present time. Peter Dragla of R.C.U.G. worked with the hemp trials and has joined Kenex as a Research Associate, responsible for seed breeding. In 1999, Kenex placed the first Canadian-bred hemp variety, Anka, on Health Canada's List of Approved Cultivars.

In 1997, R&D Hemp of Toronto and Saskatoon analyzed the oil content of hemp seed, resulting in cosmetic product development. Several companies now have cosmetic lines using hemp oil. The same year, Gordon Scheifele of University of Guelph began several research projects in northwestern Ontario.

The research of Hempline, Kenex and R&D Hemp has been aided by the governments of Canada and Ontario through the Tobacco Diversification Fund, GrowOntario, Rural Job Strategy Fund and CanAdapt. Northern Ontario research has been assisted by the Northern Heritage Fund, Fednor and Ontario Soil and Crop Improvement Association.

Through their research efforts, these entrepreneurs have learned a great deal about modern methods of producing hemp for fibre and seed. The authors will try to summarize this knowledge in the remainder of this paper.

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Development of the Industry

The hemp industry in Ontario and Canada today is still in very early stages of development. The only markets for straw or seed exist through contracts with one of the licensed grain (oilseed) or fibre processors in the province. These contracts may set out prices and parameters for marketing and production. Limited sales of uncontracted oilseed have been made to firms in the United States, but these are sporadic and result from a lot of marketing effort by entrepreneurs or brokers.

Farmers who grow hemp without a contract are putting their business at high risk of having no sale for the straw or seed. Several entrepreneurs and producer/manufacturer groups in Ontario are working hard to develop new processes and markets for fibres, grain, oil and food products.

The greatest need in the industry at this time is the development of cost-effective industrial processes to produce consistent, competitive raw fibre materials for manufacturing into quality products. This technology is lacking throughout the industrialized world, although there have been some positive developments in non-woven fibre applications, oil extraction and seed de-hulling.

The development of **hemp fibres** for manufacture of fine yarns or fabrics is not well understood in the industrialized world. Present technology is suited to under-developed countries with very low labour costs. All of the clothing made and sold in this country is made from fabric imported from Asia or Eastern Europe. Cost-effective industrial processes must be invented to enable commercial manufacture of wearable textiles in Ontario and elsewhere.

Hemp oil contains a unique mixture of omega 6 and omega 3 fatty acids, as well

as gamma linolenic acid (GLA), an acid involved in the synthesis of prostaglandins in the body. The oil is being used in the manufacture of cosmetic creams and may have a role in human nutrition as well. The main drawbacks at the present time are low yield relative to canola, oil extraction technology and, perhaps, stability. Oil may be the first area of product development to be commercialized successfully.

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Description

When grown as a fibre crop, hemp may grow to a height of 2 to 4 metres without branching. In dense plantings, the bottom leaves atrophy due to the exclusion of sunlight. Male plants die back after shedding pollen.

The stem has an outer bark which contains the long, tough bast fibres. These give the quality and strength for which hemp is renowned. The centre core contains the hurds, or short fibres, that are useful in other applications like particleboard or horse bedding.

For grain production, the plants may branch and reach heights of only 2 to 3 metres. Stalk length is not related to grain yield and shorter heights are preferred for combining.

In well-structured and well-drained soils, the tap root may penetrate 15 to 30 cm. deep. In compacted soils, the tap root remains short and the plant produces more lateral fibrous roots.

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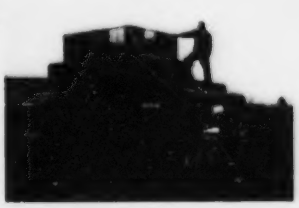
Licensing

The production, possession, processing and transportation of hemp and its products is permitted under the Industrial Hemp Regulations (IHR) and each operation is controlled by a license issued by the Therapeutic Products Directorate of Health Canada. Possession of any parts of the hemp plant or hemp products without the appropriate license is an offence under the Criminal Code. The only exceptions to this are mature stalks, minus their stems and flowers, and non-viable hemp seeds. These stems and seeds are exempt from the *Controlled Drugs and Substances Act*.

Leaf or seed residue found in vehicles or machinery, without the proper licenses, may constitute *possession of a controlled substance* in Canada or elsewhere. Thorough cleaning is advised.



Hemp licenses are issued for a calendar year only and must be renewed if product is carried into the new year. Growers should also be aware that hemp licensing is only relevant to Canada and that transporting product in any form to another country, including the United States, may constitute an offence in that country.

Licenses to grow industrial hemp are issued for crops of four hectares (ten acres) or more. Seed breeding and other small scale experimental processes may be issued research permits only.

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Varieties

Hemp varieties tested in Ontario to date have all been of European origin. They come in two types: Dioecious, which have male and female flower parts on

separate plants, and Monoecious, which have male and female flower parts on the same plant. A third type of cultivar, known as Female Predominant, has 85 to 90 per cent female plants. It is believed that this type can produce a higher yield of bast fibres.

Only pedigreed seed varieties will be approved for planting in Canada. These varieties are set out in the List of Approved Cultivars, published by Health Canada. They are known to produce plants containing less than 0.3% THC under normal conditions. The THC level may vary with stage of growth and increase under environmental stress conditions. They mature to fibre in 60 to 90 days and to seed in 110 to 150 days.

The first Canadian variety, Anka, has been developed and is on the Health Canada list. Commercial seed of this variety is not yet available. Seed supply and processing companies are expected to have adequate supply of other recommended varieties for the 1999 season.

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Soil Conditions

Hemp responds to a well-drained, loam soil with a pH (acidity) above 6.0. Neutral to slightly alkaline (pH 7.0 - 7.5) is preferred.

The higher the clay content of the soil, the lower the tonnage of fibre that will be produced. Clay soils are easily compacted and hemp is very sensitive to soil compaction.

Poorly structured, sandy soils provide very little natural fertility or support for the plant. Accordingly extra nutrients and water will be required to achieve maximum yields on these soils.

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Seedbed Preparation

Hemp seed requires good seed-to-soil contact. The seedbed should be firm, level and relatively fine, similar to that prepared for direct-seeded forages. The soil can be worked and planted as soon as the ground is dry enough to avoid compaction. A shallow, firm seedbed allows seed to be placed at a uniform depth, resulting in uniform seedling emergence.

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Planting

Hemp being planted for ***fibre*** is normally sown with a standard grain drill, in 6- or 7-inch rows, placing the seed at 2-3 cm. depth. Optimum final stand is about 200 to 250 plants per square metre (msq.). Researchers recommend a minimum seeding rate of 300 to 350 seeds per msq. Planting rate is recommended at 50 kg. per ha. This could be higher if germination is low. For ***grain*** production, desired final plant population is around 100-125 plants per msq. Seed should be planted at a depth of 2-3 cm. Optimum soil temperature at that depth for fast germination is 8 to 10°C., although hemp seed will germinate at 4 to 6°C. Soil temperature determines the optimum date of planting in any part of Ontario.

Estimated earliest dates of planting range from late April in Kent and Essex counties to mid-May in northern Ontario. Trial plots in Norfolk, Kent, Essex and Middlesex counties have been planted as late as June 10, but this is not recommended. Observations in northern Ontario indicate that grain yield may not respond as positively to early planting as does fibre yield.

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Climatic Conditions

Hemp is a heavy user of moisture. Measurements at Ridgetown College indicate that the crop required 300 to 400 mm. of rainfall equivalent. Since that amount of rainfall seldom occurs during the growing season, it is important to make use of early soil moisture and to obtain a good ground cover early to reduce surface evaporation. Young plants are very sensitive to wet soils or flooding during the first three weeks, or up to the fourth internode (about 30 cm. tall).

For grain production, about 50 per cent of this moisture is required during flowering and seed set if maximum yields are to be reached.

During the period of vegetative growth, hemp responds to daytime high temperatures in the range of 25-28°C. Young plants continue to grow at temperatures as low as 2°C., but frost tolerance in seedlings is still not established. After the third pair of leaves have developed, hemp has been known to survive temperatures as low as -0.5°C. for 4 to 5 days.

There are indications that vegetative growth slows as days become shorter, 4-5 weeks after the summer solstice (June 21). Flower development is triggered by the shortening day length. Early planting results in taller plants with higher fibre yields, without changing the cutting date significantly.

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Fertility

Hemp requires as much fertility as a crop of corn or a high-yielding wheat crop. Insufficient research has been done to define the exact nutrient requirements but experience would suggest that the following rates of fertilization will produce a good crop on most soils: Nitrogen (N), 90-125kg./ha.; Phosphorus (P), 23-75 kg./ha.; and Potash (K20), 0-90 kg./ha. Clay soils generally require lower rates of potash than lighter soils. Some of this fertility may come from previous crop residue or manure. Alkaline soils may benefit from the addition of sulfur at 20 to 30 kg./ha.

As with other crops, the balance of major nutrients with the crop requirements is important. Excessive nitrogen, combined with inadequate potash, may result in stalk breakage.

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Weed Control

If hemp is planted in well-drained, fertile soil under nearly optimum temperature and moisture conditions, it will germinate quickly and reach 30 cm. in 3 to 4 weeks from planting. At this stage it will give 90 per cent ground shade. Weed growth is suppressed by the exclusion of light from the soil. It appears that rapidly growing hemp, at a final population of 200 to 250 plants per msq., will suppress nearly all weed growth, including twitch grass.

Weed suppression is not a permanent condition. These weeds will appear on the same field next year if the field is rotated out of hemp production. Perennial grasses may be weakened or killed if hemp is grown a second year on the same ground. However, this practice increases the opportunity for crop diseases to develop.

Under grain production conditions, weed suppression may be less complete. The lower plant population or uneven stands allow more light to penetrate the canopy, aiding the germination of weed seeds. Research in northwestern Ontario indicates that plant populations as low as 50 to 100 plants per msq. may give adequate, though not 100 per cent, weed control.

There are no approved herbicides for industrial hemp. Early planting, as soon as the soil is warm enough, may be the best weed control strategy. Growers are advised to discuss weed control with their herbicide supplier.

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Diseases and Pests

More than 50 different viruses, bacteria, fungi and insect pests are known to affect the hemp crop. However, hemp's rapid growth rate and vigorous nature allow it to overcome the attack of most diseases and pests.

As the acreage of hemp and alternative disease hosts increases in a given area, the organisms will tend to increase. The following pests have been noted in hemp fields in Ontario. Botrytis cinerea (grey mold) and Sclerotinia sclerotiorum (white mold) are common molds of hemp. Sclerotinia also affects edible beans, canola and sunflowers. Fusarium, the pink mold often found on corn and wheat, has been noted on the roots of hemp plants. The effect of these diseases on these crops, or on hemp, may not be known until hemp is grown more intensively in bean and canola-growing areas.

European Corn Borer has affected some stands in southern Ontario and grasshoppers have done some damage in northern Ontario. Bertha Army Worm (Mamestra configurata) has been a pest in Manitoba and could find its way to hemp crops in northwestern Ontario.

No pesticides or fungicides are registered for hemp in Ontario. Crop rotation would appear to be a good cultural practice to avoid disease build-up until more is known about hemp's susceptibility to disease organisms. A four-year rotation is recommended.

There are some indications that hemp, in rotation with soybeans, may reduce populations of Soybean Cyst Nematode. Longer term studies need to be done to determine whether this is true, and the value of hemp in intensive cropping rotations.

Wind and hail damage can be significant in the hemp crop. Tall plants with lots of high leaves can be bent over quite easily by mid-to late-summer storms. Broken plants will partially recover if not broken too low. Small plants damaged by hail in 1996 recovered quickly and developed quite normally if they were not severed below the first node. Weather stresses may result in higher THC levels in the remaining crop.

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Harvesting Fibre Hemp

Air dry stem yields in Ontario have ranged from 2.6 to 14.0 tonnes of dry, retted stalks per hectare or 1 to 5.5 tonnes per acre at 10 to 15 per cent moisture. Yields in Kent County have averaged 3.5 tonnes per acre (8.75 t/ha). Northern Ontario crops averaged 6.1 t/ha in 1998. Researchers feel that higher yields can be reached with earlier planting and optimum growing conditions.

Approximately one tonne of fibre can be decorticated from 3 to 4 tonnes of good quality dry straw. Yield varies with both the variety and the quality of fibre desired. Further processing may be required to attain the quality of fibre needed for some end uses.

For textile applications, hemp should be cut in the early flowering stage or while pollen is being shed, but before seed sets. Fibre that is cut after seed harvest will have lignified considerably and is usable only in some non-woven industrial fibre applications.

On small acreage, good quality sickle-bar mowers and hay swathers have been used to cut hemp. Frequent plugging has been a constant problem with this equipment. As acreage increases, more sophisticated equipment may have to be imported or developed.

There are no reliable price or quality indicators in Ontario at the present time.

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Retting and Turning

Retting is the process of beginning to separate the bast fibres from the hurds or other plant tissues. It is done in the field, taking advantage of the natural elements of dew, rain and sun, or under controlled conditions using water, enzymes or chemicals. The method chosen depends on the end use to which the fibre will be put. Suitable industrial processes for water and chemical retting have not been developed.

Successful field retting requires a delicate balance of nightly dews and good daytime drying conditions. The southern Ontario climate may dictate that field retting be done no earlier than the end of July in order to assure adequate dew conditions. The length of the retting process is critical for optimum fibre yield and quality. It normally takes 14 to 21 days to complete.

The windrows are turned vigorously once or twice with a tedder or windrow inverter to facilitate even retting of the windrow and to knock the leaves off the stems. In wet conditions, a third turning may be necessary. Excessive leaves will hinder drying and may cause the straw to contravene the Controlled Drugs & Substances Act.

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Baling and Storing

Baling can be done with any kind of baler. Large round, soft-core balers may be most satisfactory to allow bales to dry more quickly in storage. For some industrial processes, the buyer may require a uniform large, square bale to fit into the processing system. This may present a challenge in preventing spoilage if the bales are stored for later delivery, because square bales may be packed more tightly than round bales.

Bales must be stored indoors under dry conditions to stop the retting process before the fibres become rotted. Stalk moisture should be less than 15%. No observations have been made to date on bales stored under plastic, but experiments with hay storage would indicate that moisture would be wicked up from the ground and some spoilage would take place unless they can be separated from the bare ground.

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Combining Grain Hemp

Combining hemp provides a special challenge to the combine operator. Large quantities of plant material are put through the combine, because of the height of the hemp crop. This volume, and the tendency of hemp fibres to wind around moving parts, leads to frequent plugging of the threshing bed and cylinder, and a great deal of frustration and time lost by the operator. Early grain varieties such as Fedora 19, FIN314 and Fasamo are shorter and easier to combine.

Hemp seed is harvested when the seed begins to shatter. At this point, about 60 per cent of the seed is ripe and about 22-30 per cent moisture. Later combining will result in increased seed losses due to shattering and lower quality grain.

Raising the cutting blade to about 1 metre (40 inches), or as high as the header will cut effectively, will reduce the amount of material entering the combine. The header knife must be kept sharp at all times to minimize winding of fibres on the sickle bar. Replacing the slatted feeder conveyor with a belt may help to reduce the amount of fibre that winds on the feeder shaft.

Some experimentation with ground speed, concave openings and cylinder speeds

may be necessary. The following settings are recommended by Paul McGrail of McGrail Farm Equipment: cylinder speed at 250 RPM, fan speed at 1070 RPM, 1/8-inch sieve and 3/8-inch chaffer, concave set tight. Run feeder housing chain loose in the corn position and close the pre-cleaner. Lower the beater grate, remove the curtains and install a speed-up kit for the beaters. Rotary combines do not seem to be satisfactory for harvesting hemp grain at the present time, because of plugging difficulties.

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Economics of Production

Costs of production will vary with individual circumstances. Small acreages. low yields, age and cost of equipment used, other uses for the land and cost of land all contribute to the cost of producing a tonne of hemp straw or grain.

The worth of the straw will vary according to its value in the market place. Thus, factors such as the method of retting, quality of storage and the demand for the specific quality of fibre produced will affect the farm-gate price. Yield of straw will affect both costs and returns per hectare.

The price of hemp straw is quite hypothetical because only a small amount has been sold, and none on the open market. Contracts have only been signed for one year at the present time and it is not known if the price offered was representative of the true market value. Grain prices have been reported between 45 and 55 cents per pound.

The following budget outlines are intended to be a guide only. Growers should complete their own budgets using actual cost assumptions.

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Crop Budget (Hemp for Fibre)

Operating	Assumptions	Fibre Crop	Your Cost
Supplies			
Seed	50 lb @ $3.30/lb	165.00	_____
Fertilizer	135 MAP 11-52-0	70.00	_____
	70/Muriate of Potash 0-0-60		
	250 U.A.N. 28-0-0		
Herbicide	_____ lb @ ____ lb/ac	_____	_____
Insecticide/Fungicide	_____ lb/ac @ ____ $/lb	_____	_____
Operations			
Primary Tillage	Ploughing, etc.	20.00	_____
Cultivating/discing	2 passes @ 8/ac	16.00	_____
Seeding, packing	Drill with packing wheels	15.00	_____
Global Positioning		10.00	
Sampling & THC Testing	Based on 4 ha min., 1 variety	30.00	_____
Cutting & Swathing		25.00	_____
Retting	Tedder or Swath Turner - 2 passes	25.00	_____
Baling		65.00	_____
Storage		70.00	_____
Loading & Trucking		75.00	_____
Land Rent		_____	_____
Hired Labour/Consulting		_____	_____
Interest on Operating Cost	8% for 6 months	23.00	_____
TOTAL OPERATING EXPENSES		**609.00**	
Overhead Expenses			
Machinery - Depreciation		_____	_____
Machinery - Interest on Investment		_____	_____
Land Cost		_____	_____
Other Overhead		_____	_____
Total Fixed Costs		_____	_____
TOTAL EXPENSES		_____	_____
Revenue			
Expected Yield	3.5 tonnes		
Expected Price	$180.00/tonne	**630.00**	_____
TOTAL REVENUE			
Gross Margin	Total Revenue - Operating Expenses	**21.00**	_____

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Crop Budget (Hemp for Grain)

Operating	Assumptions	Grain Crop	Your Cost
Supplies			
Seed	40 lb @ $3.30/lb	132.00	
Fertilizer	135 MAP 11-52-0	70.00	
	70/Muriate of Potash 0-0-60		
	250 U.A.N. 28-0-0		
Herbicide	_____ lb/ac @ ____ $/lb	_____	
Insecticide/Fungicide	_____ lb/ac @ ____ $/lb	_____	
Operations			
Primary Tillage	Ploughing, etc.	20.00	
Cultivating/discing	2 passes @ 8/ac	16.00	
Seeding, packing	Drill with packing wheels	15.00	
Global Positioning		10.00	
Sampling & THC Testing	Test $15 + Sampling $15	30.00	
Combining		70.00	
Cutting & Swathing	Tedder or Swath Turner - 2 passes	25.00	
Retting		25.00	
Baling		40.00	
Trucking Grain	$6 per tonne	3.00	
Storing Grain		_____	
Storing Straw		45.00	
Trucking Straw	Includes Loading	50.00	
Land Rental		_____	
Hired Labour		_____	
Interest on Operating Cost	8% for 6 months	22.00	
TOTAL OPERATING EXPENSES		**573.00**	
Overhead Expenses			
Machinery	Depreciation and interest	_____	
Storage Structures	Depreciation and interest	_____	
Other Overhead		_____	
Total Fixed Costs		_____	
TOTAL EXPENSES		_____	
Revenue			
Grain	800 lb @ $0.45/lb (range=300 to 1500 lb/ac)	360.00	
Straw	2.0 tonnes @ $150/tonne	300.00	
TOTAL REVENUE		**660.00**	
Gross Margin	Revenue - Operating Expenses	**87.00**	

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